

**ASPECTS ON THE CHEMICAL COMPOSITION OF POTATOES TUBERS  
(VARIETY ALBASTRIU MOV) INFESTED WITH SPECIES  
*Ditylenchus destructor* Thorne, 1945**

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**Abstract**

*It was determined that, in the potatoes tubers (*Solanum tuberosum* L.), variety Albastru mov, infested with nematode *Ditylenchus destructor*, the invasion intensity is 613.3 individuals/gram, the amount of dry matter is lower - 17%, than in non infested potatoes - 23%, the amount of protein is also decreasing and the amount of water is with 5% higher. The investigated potatoes tubers contain all 20 proteinogenic amino acids (AA), characteristic for plants, but the difference is that the amount of amino acids detected in infested tubers decreases, compared to that contained in non infested ones. In both infested and non infested potatoes tubers, the maximum values belong to non-essential amino acids - aspartic acid + asparagine (24.6% - non infested potatoes; 18.4 - infested potatoes) and glutamic acid + glutamine. We found that the quantitative variations of the main components - dry matter, water, proteins, amino acids, which occur in the infested plant tissue of potatoes tubers *Solanum tuberosum*, are directly dependent on the presence of the parasite *Ditylenchus destructor*, in the process of nutrition with the cytoplasmic content of the plants cells, as well as invasion intensity.*

**Key words:** amino acids, potatoes tubers, *Ditylenchus destructor*, infestation.

**INTRODUCTION**

The nutritional importance of potatoes tubers (*Solanum tuberosum* L.) is due to the content of proteins (0.7-4.6%), carbohydrates (13-30%), lipids (0.02-0.96%), starch (70%), cellulose (0.2-3.5%), pectin (2.5%), mineral substances (0.4-1.9%), as well as other biologically active compounds (Starodub & Gheorghiev, 2008; Scurihina, 1987). Potatoes tubers is one of the main important food products of vegetable origin that provide human body with essential amino acids (AA) in necessary proportions. In the previous researches, it was determined that in the tubers varieties Irga and Romano, the content of dry matter varied between 13 and 16.7%, the amount of water constituted 87 and 83.3%, respectively. It was determined that in infested potatoes with the nematode *Ditylenchus destructor*, the amount of dry matter decreases, and the amount of water increases (Melnic, 2022; Melnic et al., 2022). Of great importance is the protein from potato tubers. Its value is determined by the content of amino acids, especially the indispensable ones. The average crude protein content is 2% of the

fresh substance and depending on the potato variety, but the essential amino acids, as well as the balanced ratio between them, give the potato a significant nutritional value. The total amount of proteins resulting from potato tubers cultivated on 1 ha is similar to that obtained from 1 ha cultivated with wheat (Starodub & Gheorghieva, 2008). Amino acids from which protein synthesis takes place are also called proteinogens, or natural amino acids, being the main organic compounds that participate in protein synthesis.

Most of the diseases in *Solanum tuberosum* culture are caused by obligate phytoparasitic nematodes with a specific pathogenic effect, among which the tuber nematode of the genus *Ditylenchus*, species *Ditylenchus destructor* Thorne, 1945, which parasitizes in association with secondary tuber parasites such as: saprophytic nematodes, fungi, bacteria, mites etc. In the Republic of Moldova, the species *D. destructor* often causes damages of 35-40% (Melnic et al., 2014)

The structure of nematode communities with a free-living and parasitic mode of life in agrocenoses can serve as a bioindicator, which

reflects the ecological-sanitary conditions of the soil and the state of the environment. In relation to changes of farming methods that took place in the Republic of Moldova, the succession of assortment and the introduction of new varieties of plants, the import of planting material, without being subject to a phytosanitary control and its planting in the soil, which has not been preventively tested to the presence of dangerous and quarantine phytoparasites nematodes, facilitates the emergence of their outbreaks and the reduction of the quality and productivity of crops. In relation to changes in farming methods. In this study are presented data on physiological-biochemical changes (quantitative variations in the content of dry matter, water, protein, proteinogenic amino acids), occurring in the infested tissue of potato tubers of the variety Albastru mov, in contact with nematode species *Ditylenchus destructor* Thorne, 1945.

## MATERIALS AND METHODS

Research was conducted to evaluate changes in the main biochemical indices - the amount of dry mass, water, protein and proteinogenic amino acids in potato tubers of the variety Albastru mov, both in those infested with the nematode *Ditylenchus destructor* Thorne, 1945, and in those non infested, free of nematodes (the control). The researches took place between the 2018-2022 years.

To carry out such research, as well as to obtain truthful data, potatoes of the variety Albastru mov were infested only with the main tuber parasite - *Ditylenchus destructor*. Such tubers (in the II phase of ditylenhosis) can be obtained by the inoculation method, in vegetative experiences (Melnic et al., 2018). For the biochemical analyses, potato tubers of the Albastru mov variety infested with *D. destructor*, as well as non infested, free of nematodes, obtained in vegetative experiments, were selected immediately after harvesting. The tubers sampled were analyzed for the presence, purity and density of the nematode *Ditylenchus destructor*. The extraction of

nematodes from the infested tissue was performed using the classic method of Baermann funnels, modified by Nesterov (1979). Fixed preparations were performed according to the Seinhorst method (Van Bezooigen, 2006).

For biochemical analysis, the tubers infested only by the species *Ditylenchus destructor*, in the first phases of ditylenhosis, obtained through inoculation method, were selected (Melnic et al., 2018; Melnic et al., 2016). Dry mass and water content were calculated according to the methods of Ermakova (1987), Tsitovichi (1974). The proteinogenic amino acids in the biological material were determined by the method of hydrolysis with hydrochloric acid (HCl) 6N and ion chromatography with the amino acid analyzer (Garaeva et al., 2009). Total protein was calculated according to Skurihina, 1987.

## RESULTS AND DISCUSSIONS

**The density of *Ditylenchus destructor* individuals/tubercle.** The variety Albastru mov is a food potato variety, category a, quite rare. In our research it was collected from individual households. It is a delicious variety, due to its rich content of vitamins and trace elements. In the selected portions of potatoes tubers, intended for biochemical analyses, the density and purity of *Ditylenchus destructor* populations was determined first. The laboratory analyzes carried out on potatoes variety Albastru mov infested with *D. destructor* in II phase, beginning of III phase of ditylenhosis (Figure 1), demonstrated that in the vegetable tissue of their pulp, the density of *D. destructor* was 613.3 individuals/gram. Fixed preparations were performed, according to which the nematodes species in the analyzed potatoes tubers was determined. It is very important to mention, that the presence of microorganisms was not observed in the experimental potato tubers, and in the extracted suspension individuals only species - *D. destructor* - mature forms, larvae, eggs, were present.



Figure 1. Potatoes *Solanum tuberosum* L. (variety Albastru mov): A - non infested; B - infested with *Ditylenchus destructor*, used in the original biochemical analyses

**Changes in the amounts of dry matter and water.** It was determined that as a result of the parasitic impact of *Ditylenchus destructor*+potato tubers of variety Albastru mov, there are quantitative deviations in the content of dry matter and water (Figure 2). In the non infested potatoes, the amount of water was 77%, and in the infested potatoes - 83%, that is, it is higher by 6%. At the same time, it was observed that the amount of dry matter in

infested potatoes is lower - 17%, than in non-infested potatoes - 23%. Previous research, carried out on other varieties of potatoes (Romano, Irga), infested with *D. destructor*, also showed that under the influence of the parasite, the amount of dry matter decreases and the amount of water increases (Melnic, 2022; Melnic et al., 2018; Melnic et al., 2021; Melnic et al., 2022).

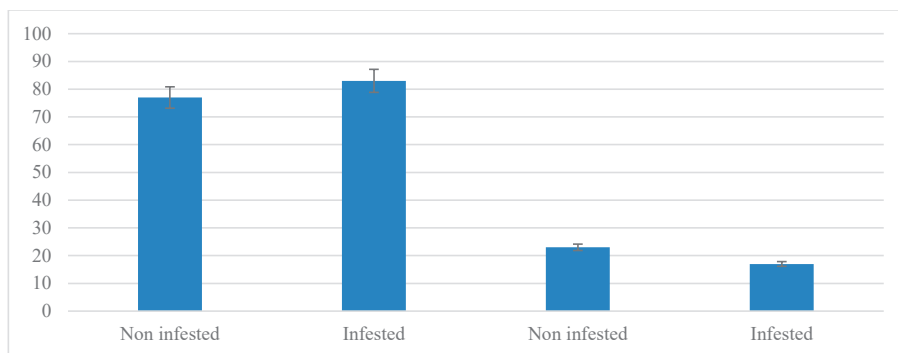


Figure 2. Quantitative variations (%) of water (1; 2) and dry matter (3; 4) in potatoes variety Albastru mov infested with *Ditylenchus destructor* compared to non infested ones

Changes in the content of dry matter and water result from the fact that in the process of nutrition the parasite consumes the cytoplasmic content of the cells through the stylet. In the research process, it was also observed that the content of dry matter and water in non-infested potato tubers depends on the variety. If we compare the non infested tubers varieties Albastru mov, Romano and Irga, it is obvious, that the tubers potato variety Albastru mov are

richer in dry matter (23%), being valued at average values (according to Starodub; Gheorghiev, 2008), which also contain a smaller amount of water (77%) (Figure 3), and less dry matter (13%), valued at minimum values, as well as a higher percentage of water (87%) are contained in the Irga potato variety. All three varieties are distinguished by their low starch content of 12-13.8%, being appreciated as food varieties.

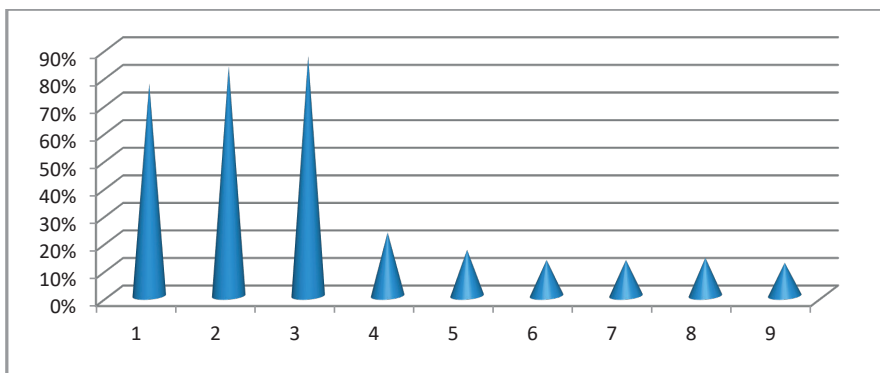


Figure 3. Percentage distribution of water (1; 2; 3), dry matter (4; 5; 6) and starch (7; 8; 9) amounts; (after: Starodub, Gheorghiev, 2008) in non infested potato tubers by different varieties: Albastru mov (1; 4; 7), Romano (2; 5; 8), Irga (3; 6; 9)

### Changes in the amounts of amino acids and protein.

In the tubers of *Solanum tuberosum* not infested with the variety Albastru mov, there are 20 amino acids (AA), specific for plants: aspartic acid + asparagine (Asp+Asn), glutamic acid + glutamine (Glu+ Gln), alanine (Ala), cysteine (Cis), glycine (Gly), isoleucine (Ile), leucine (Leu), tyrosine (Tyr),

methionine(Met), phenylalanine (Phe), serine (Ser), threonine (Thr), valine (Val), arginine (Arg), histidine (His), lysine (Lys), proline (Pro), tryptophan (Trp). Quantitative variations of proteinogenic AA from non infested potato variety Albastru mov are indicated in Table 1 and Figure 4.

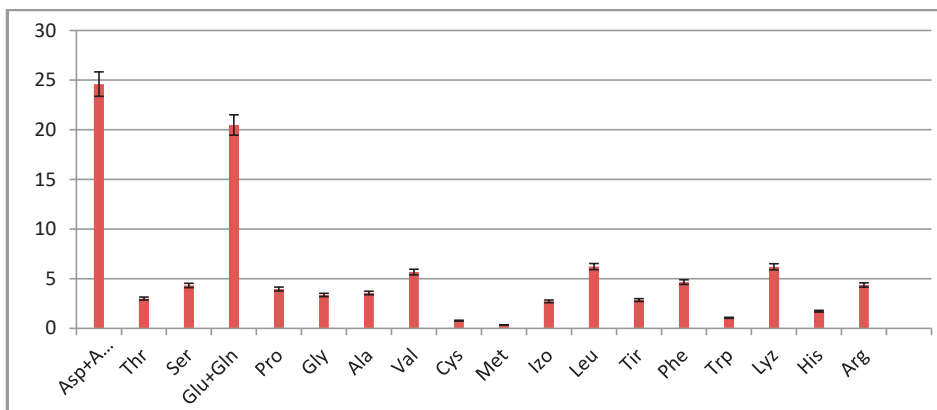


Figure 4. Percentage (%) distribution of amino acids in the plant tissue of non infested potato tubers variety Albastru mov

We observe that, in healthy potato variety Albastru mov, cultivated under the Republic of Moldova conditions, the maximum percentage belongs to amino acids - Asp+Asn (24.6%) and Glu+Gln (18.4%) which, according to the data of some authors (Гараева, 2009), also include in the group of non-essential (dispensable) amino acids and in the group of immunoactive amino acids. A higher

percentage 5.66-6.22% belongs to Val, Leu and Lys, and most amino acids (AA) have values between 3.0-4.37%. The smallest amounts has Cis (sulfur-containing amino acid) - only 0.78% of the total amount of amino acids, followed by Met (sulfur-containing) - 0.35%. One of the researched amino acids - cysteine acid (Cys) is not frequent in non infested potatoes.

Table 1. The amount of amino acids and nitrogen (mg/100 mg substrate), percentage distribution in potatoes tubers variety Albastru mov

Amino acids		Non infested potatoes			Infested potatoes		
		AA	% from total	Nitrogen (N)	AA	% from total	Nitrogen (N)
	Cys	-	-	-	-	-	-
1-2.	Aspartic acid +Asparagine	0.417	24.6	0.0439	0.221	18.4	0.032
3.	Threonine	0.051	3.0	0.006	0.038	3.16	0.0045
4.	Serine	0.073	4.32	0.0098	0.064	5.33	0.0085
5-6.	Glutamic acid + Glutamine	0.347	20.48	0.033	0.212	17.65	0.0201
7.	Proline	0.067	3.96	0.0082	0.071	5.91	0.0087
8.	Glycine	0.057	3.36	0.0107	0.054	4.50	0.01
9.	Alanine	0.060	3.56	0.0095	0.058	4.73	0.009
10.	Valine	0.096	5.67	0.0115	0.071	5.91	0.0084
11.	Cysteine	0.013	0.78	0.003	0.006	0.50	0.0014
12.	Methionine	0.006	0.35	0.0005	0.007	0.57	0.0006
13.	Isoleucine	0.046	2.72	0.0049	0.037	3.08	0.0038
14.	Leucine	0.105	6.22	0.0113	0.079	6.56	0.0084
15.	Tyrosine	0.048	2.85	0.0037	0.045	3.75	0.0035
16.	Phenylalanine	0.079	4.66	0.0067	0.073	6.08	0.0062
17.	Tryptophan	0.018	1.06	0.0025	0.013	1.08	0.0018
18.	Lysine	0.105	6.2	0.0201	0.078	6.50	0.0149
19.	Histidine	0.029	1.73	0.008	0.028	2.30	0.0076
20.	Arginine	0.074	4.37	0.0238	0.048	4.0	0.0154
	Summary ( $\Sigma$ )	1.694	100	0.2171	1.201	100	0.1563
	Protein			1.36			0.977

The maximum values also belong (as in non infested potatoes) to non essential amino acids - Asp+Asn (18.4%) and Glu+Gln (17.65%), followed by some amino acids with comparatively higher values such as Ser (5.33%), Pro (5.91%), Val (5.91%), Leu (6.56%), Phe ( 6.08%) and Lys (6.5% of the total). As in the case of non infested potatoes, in infested potatoes, the minimum values belong to Cis (0.013%) and Met (0.006%) (Table 1, Figure 5), and cysteine acid is missing. In infested potatoes, amino acids Asp+Asn and Glu+Gln decrease quantitatively by 1.9-1.6 times, respectively, compared to non infested ones, and total amino acids decreases by 1.4 times. In previous research (Melnic et al., 2022; Melnic et al., 2021), carried out on the potato tuber variety Irga,

with a population density of 600-700 individuals/gram approximately as in the case of variety Albastru mov, it was determined that all amino acids in the infested tissue decrease quantitatively, compared to the non-infested plant tissue. Unlike the varieties Albastru mov and Irga, in the variety Romano infested tubers, with *Ditylenchus destructor* population density of 1.3-1.4 x10<sup>3</sup> individuals/gram of tissue, an increase in the investigated amino acids was observed, as well as their quantities, according to the functional groups (Melnic, 2022).

In potato variety Albastru mov infested with *Ditylenchus destructor*, the amount of protein was 0.977%, decreasing compared to the uninfested ones -1.36%.

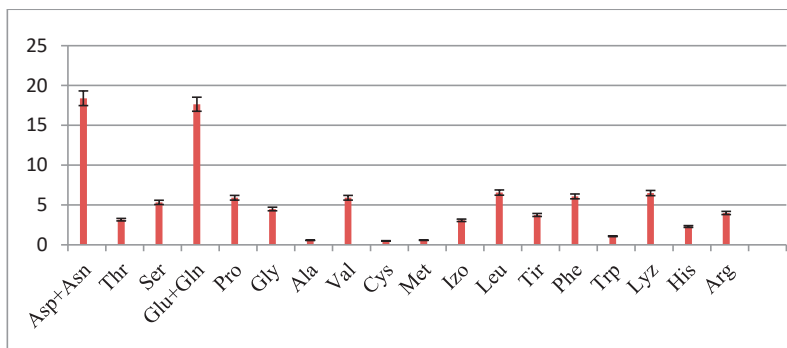


Figure 5. Percentage (%) distribution of amino acids in the plant tissue of infested potatoes tubers variety Albastriiu mov

**Distribution of amino acids by functional groups.** From the obtained results (Table 2, Figure 6), we note that according to the functional groups, the uninfested potatoes variety Albastriiu mov, free of *D. destructor*, are distinguished by the content of non-

essential amino acids - 1.083 mg/100 mg researched material, immunoinactive amino acids - 1.076 mg/100 mg and glycogenic amino acids - 0.755 mg/100 mg, followed by essential amino acids - 0.612 and ketogenic amino acids - 0.403 mg/100 mg.

Table 2. Quantitative distribution of amino acids by functional groups

Amino acids		Non infested	Infested
I.	<i>Essential amino acids</i>		
1.	Threonine	0.05	0.04
2.	Valine	0.10	0.07
3.	Methionine	0.006	0.007
4.	Isoleucine	0.05	0.04
5.	Leucine	0.105	0.08
6.	Fenilalanine	0.079	0.079
7.	Tryptophan	0.018	0.013
8.	Lysine	0.105	0.078
	Summary (Σ)	0.612	0.471
II.	<i>Non essential amino acids</i>		
1.	Arginine	0.074	0.048
2.	Serine	0.073	0.064
3.	Cysteine	0.013	0.006
4.	Glycine	0.057	0.054
5.	Proline	0.067	0.071
6.	Histidine	0.029	0.028
7.	Tyrosine	0.048	0.045
8.	Glutamic acid + Glutamine	0.347	0.212
9.	Aspartic acid + Asparagine	0.417	0.221
10.	Alanine	0.060	0.058
	Summary (Σ)	1.083	0.730
III.	<i>Immuno active amino acids</i>		
1.	Aspartic acid + Asparagine	0.417	0.220
2.	Threonine	0.051	0.038
3.	Serine	0.073	0.064
4.	Glutamic acid + Glutamine	0.035	0.212
5.	Alanine	0.060	0.058

6.	Valine	0.096	0.071
7.	Tryptophan	0.018	0.013
8.	Cysteine	0.013	0.006
	Summary ( $\Sigma$ )	1.076	0.682
IV.	<i>Glucogenic amino acids</i>		
1.	Aspartic Acid +Asparagine	0.417	0.221
2.	Threonine	0.051	0.038
3.	Serine ( $\Sigma$ )	0.073	0.064
4.	Glycine	0.057	0.054
5.	Alanine	0.060	0.058
6.	Valine	0.096	0.071
	Summary ( $\Sigma$ )	0.755	0.505
V.	<i>Ketogenic amino acids</i>		
1.	Isoleucine	0.046	0.036
2.	Leucine	0.105	0.079
3.	Tyrosine	0.048	0.045
4.	Phenylalanine	0.079	0.073
5.	Lysine	0.105	0.078
6.	Tryptophan	0.018	0.013
	( $\Sigma$ ) Summary	0.403	0.324
VI	<i>Sulfur-containing amino acids</i>		
1.	Methionine	0.006	0.007
2.	Cysteine	0.013	0.006
3.	Cysteic acid	-	-
	Summary ( $\Sigma$ )	0.019	0.013

We mention, that in infested potatoes with species *Ditylenchus destructor*, compared to the non infested ones, there is a significant decrease in the amounts of amino acids: immunoactive - 1.6 times, non-essential - 1.5 times, glycogen - 1.5 times and essential - 1.3 times. It also reduces quantitatively amino acids from the ketogenic and sulfur-containing groups. These research demonstrated that the

quantitative variations of the main components - dry matter, water, proteins and amino acids. which occur in the infested plant tissue of tubers *Solanum tuberosum* are directly dependent on the presence and density of the parasite *Ditylenchus destructor*, due to the process of nutrition with cytoplasmic content of plant cells.

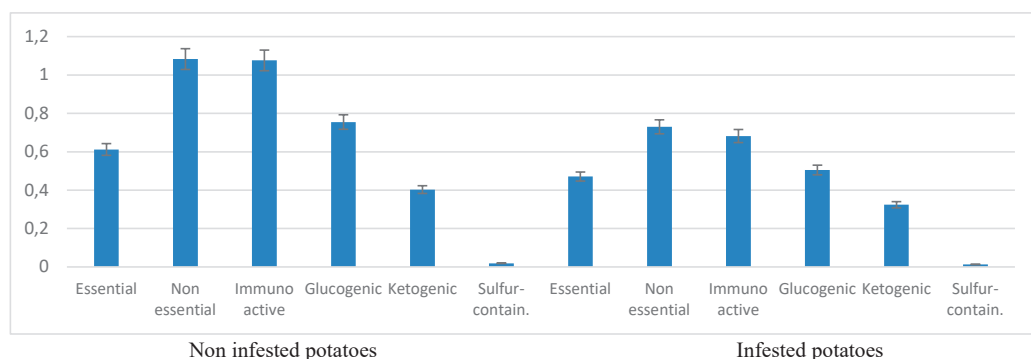


Figure 6. Distribution of the amounts of amino acids by functional groups in non infested and infested potatoes variety Albastrii mov with *Ditylenchus destructor* (mg/100 mg researched material)

Our data are similar to the data obtained by some authors (Krivodubskaya, 1968), who observe that in the plant cells of the potatoes pulp infested in phase II, the beginning of phase III of ditylenhosis. in which nematodes *Ditylenchus destructor* have penetrated. there is a decrease in the content of proteins and amino acids. because these substances are absorbed by the parasite in the nutrition process.

## CONCLUSIONS

It was determined that, as a result of the parasitic impact of species *Ditylenchus destructor*+ potato tubers variety Albastru mov there are quantitative deviations of dry matter and water content. In non infested potatoes the amount of water is 77%. and in infested potatoes - 83%. At the same time, it was observed that the amount of dry matter in infested potatoes is lower - 17%, than in non-infested potatoes - 23%.

It was demonstrated that in tubers potatoes variety Albastru mov infested with nematode *Ditylenchus destructor*, the amount of protein constituted 0.977%, being in decrease compared to the non infested ones - 1.36%.

Researches have shown that infested potatoes, like uninfested ones, contain 20 amino acids. The amount of amino acids detected in infested tubers decreases significantly, compared to their amount in non-infested tubers. In both, the maximum values belong to non-essential AA - Asp+Asn (24.6% - non infested potatoes; 18.4 - infested potatoes) and Glu+Gln (20.48% - non infested potatoes and 17.65% infested potatoes) and the minimum values belong to sulfur-containing amino acids - cystine and methionine.

Was highlighted, that in infested potatoes with species *Ditylenchus destructor*, compared to the non infested ones, according to the distribution of amino acids by functional groups, there is a significant decrease in the amounts of amino acids: immunoactive - 1.6 times, non-essential - 1.5 times, glycogen - 1.5 times and essential - 1.3 times. It also reduces quantitatively amino acids from the ketogenic and sulfur-containing groups.

The obtained results demonstrated that the quantitative variations of the main components - dry matter, water, proteins and amino acids, which occur in the infested plant tissue of

tubers *Solanum tuberosum*, are directly dependent on the presence and density of the parasite nematode *Ditylenchus destructor*, due to the process of nutrition with cytoplasmic content of plant cells.

## ACKNOWLEDGEMENTS

This research work was carried out within the State Program 20.80009.7007.12 The diversity of hematophagous arthropods, zoo and phytohelminths vulnerability strategies to tolerate climatic factors and the development of innovative procedures for the integrated control of species of socio-economic interest and the Program Zoo Aquaterra 010701. The evaluation of the structure and functioning of the animal world and aquatic ecosystems under the influence of biotic and abiotic factors in the context of ensuring ecological security and the well-being of the population.

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